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New records from Turkey: *Cortinarius barbatus*, *C. osmophorus*, & *C. saturninus*

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ABSTRACT—Three *Cortinarius* species, *C. barbatus*, *C. osmophorus*, and *C. Saturninus*, have been identified as new records for the Turkish mycota based on macro- and micromorphological characters, and their identifications were supported by molecular (rDNA ITS) phylogenetic data. The Turkish specimens are illustrated, and their diagnostic characters are compared with published descriptions of the same species and related taxa.

KEY WORDS—Agaricales, Cortinariaceae, Eastern Anatolia, Bingöl, Bitlis, Hakkâri

Introduction

Cortinarius (Pers.) Gray is a taxonomically complex genus of *Cortinariaceae* that shows a high degree of morphological variability (Liimatainen 2013). Morphological characters include a convex (often umbonate) smooth pileus, emarginate to adnate lamellae, brown to rusty brown ornamented basidiospores, and a cobweb-like partial veil attaching stipe and pileus (Ammirati & al. 1985, Hoiland & Holst-Jensen 2000). The two most diagnostic characters of the genus are the presence of a cortina (partial veil) between the pileus and the stipe and rusty brown spores (Kirk & al. 2008, Uzun & al. 2013).

Cortinarius is the largest genus of ectomycorrhizal fungi, distributed worldwide in temperate areas, coniferous forests, and arctic and alpine tundra (Brandrud & al. 1990–2018). Many *Cortinarius* species are endemic, probably due to climatic and edaphic factors (Garnica & al. 2005; Stefani

& al. 2014). The many cryptic taxa within the genus complicate species identification (Niskanen & al. 2013). The varying interpretations of morphological characters among mycologists often cause disagreements over species concepts (Liimatainen 2013), which has produced a proliferation of synonymous species names within the genus.

Most researchers have used molecular markers to support their species identification (Garnica & al. 2003, 2005, 2009; Peintner & al. 2003; Frøslev & al. 2005, 2007; Ortega & al. 2008; Liimatainen & Niskanen 2013; Stensrud & al. 2014; Stefani & al. 2014; Liimatainen & al. 2017; Sesli & Liimatainen 2018). Garnica & al. (2005) and Frøslev & al. (2007) showed that the rDNA ITS region is a particularly useful marker for species level identification for *Cortinarius*.

The literature (Sesli & Denchev 2014; Akata & al. 2015; Güngör & al. 2015; Sesli & Moreau 2015; Sesli & al. 2015, 2016; Sesli 2018; Sesli & Liimatainen 2018; Acar & Kalmer 2018; Kalmer & al. 2019) has reported 116 *Cortinarius* species from Turkey.

Three additional *Cortinarius* species—*C. barbatus*, *C. osmophorus*, *C. Saturninus*—reported as new for Turkey and supported by morphological characters and molecular data are described below.

Materials & methods

Taxon sampling and morphological studies

Cortinarius samples were collected from Turkey's Bitlis, Hakkâri, and Bingöl provinces in 2018. During fieldwork, specimens were photographed with a Canon (EOS 60D) camera equipped with a Tokina 100 mm macro lens. Macroscopic characters (pileus, stipe, lamellae, and cortina) were recorded from fresh materials. Measurements were made of at least 50 spores and 20 basidia and cheilocystidia from two samples of each specimen. Sections were mounted in distilled water, congo red, and 3% KOH solution for examination of spores, basidia, basidiospores, and marginal cells under a Leica EZ4 stereo microscope and tissues under a Leica DM500 research microscope. Measurements were made using the Leica Application Suite (version 3.2.0) programme and identified according to *Cortinarius* literature (Lange 1938; Zerova & al. 1979; Arnolds & Kuyper 1995; Phillips 2006; Frøslev & Jeppesen 2008; Brandrud & al. 2012, 2014; Liimatainen & al. 2014; Soop 2018). Specimens were deposited in the Fungarium of Van Yüzüncü Yıl University (VANF).

Molecular studies

Genomic DNA was extracted from dried basidiomata using the CTAB method (Doyle & Doyle 1987). The purity and quantity of extracted DNA were determined by using NanoDrop2000c UV-Vis Spectrophotometer and 0.8%

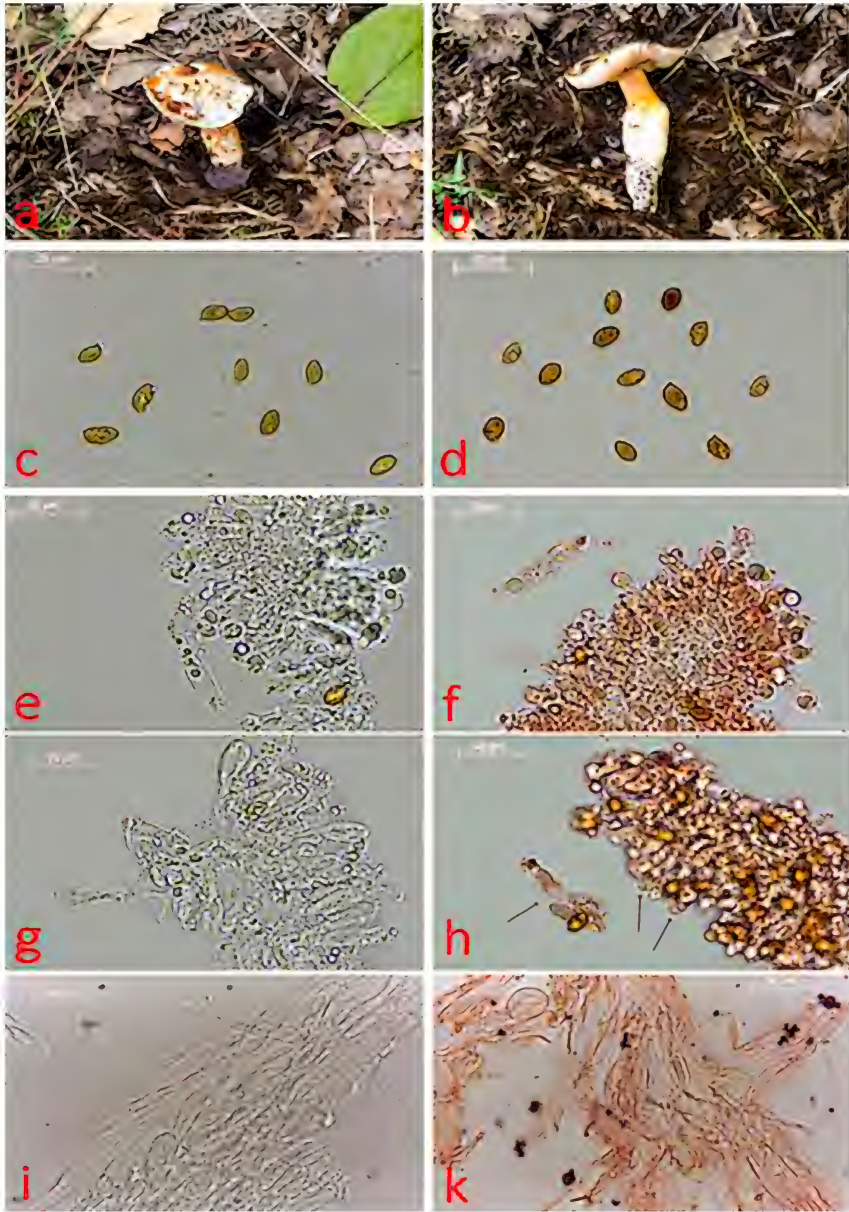


FIG. 1. *Cortinarius barbatus* (VANF Acar1076): a, b. Basidiocarp; c, d. Basidiospores; e, f. Basidia; g, h. Marginal cells; i, k. Pileipellis. (d, f, h, k in Congo Red).

agarose gel electrophoresis. DNA was amplified in 25 µl volume mixtures containing genomic DNA (10 ng/µl), 10× PCR Buffer, MgCl₂ (25 mM), dNTP mixture (10 mM), selected primer pair (10 µM), Taq polymerase (5u/µl) and sterile water. The ITS (ITS1-5.8S-ITS2) region was amplified using primer pairs N-nc18S10 5'AGGAGAAGTCGTAACAAG3' and C26A 5'GTTTCTTTTCCTCCGCT3' (Wen & Zimmer 1996). The amplicons were run in a 1% agarose gel and visualized by staining with Gelred dye. Positive reactions were sequenced with forward and reverse PCR primers in an ABI 3730XL automated sequencer, and the resulting sequences were assembled and edited using Alibee Multiple Alignment 3.0 software from the GeneBee website (www.genebee.msu.su/genebee.html). Ambiguous sites were checked manually and corrected through strand comparison. The newly generated ITS sequences were deposited in GenBank.

Phylogenetic results

The amplified ITS region was approximately 650 bp long and encompassed the complete ITS1, 5.8S and ITS2 subregions. Basic Local Alignment Search Tool (BLAST) (Altschul & al. 1997) analysis was performed using the National Center for Biotechnology Information (NCBI) database. Identity values of our three specimens were: *C. barbatus* 99.14%; *C. saturninus* 99.78%; and *C. osmophorus* 100%.

Taxonomy

Cortinarius barbatus (Batsch) Melot, Doc. Mycol. 20(77): 94 (1989) FIG. 1

PILEUS 20–50 mm, hemispherical when young, later convex to plane, sticky, glabrous, white to ivory with a white margin. LAMELLAE cream colored when young, later greyish cream brown and brown colored when mature. STIPE 35–70 × 5–10 mm, cylindrical to ventricose-fusiform and rooting, the aerial portion is yellowish brown over a white ground, the subterranean portion is white, longitudinally fibrillose, weakly viscid.

BASIDIOSPORES 7–9.5(–9.8) × 4–5(–5.7) µm, amygdaliform, rather weakly verrucose, pale straw-colored. BASIDIA 24–35 × 6–8.4 µm, cylindrical to clavate, guttulate, hyaline. MARGINAL CELLS 14.5–23 × 5.2–7 µm, clavate, hyaline. PILEIPELLIS hyphae ≤27 µm diam, clamp connections absent.

SPECIMEN EXAMINED: TURKEY, HAKKÂRI, Şemdinli, Öveç village, 37.3718°N 44.4762°E, 1484 m, under *Populus* and *Quercus* sp., 15.10.2018, I. Acar (VANF Acar1076; GenBank MN197665).

COMMENTS—*Cortinarius barbatus* is characterized by its white cap and stipe, bitter flesh, cream-greyish gills, and amygdaliform spores. According to Soop (2018), key characters of *C. barbatus* are its white cap and bitter flesh, which our material also possesses.

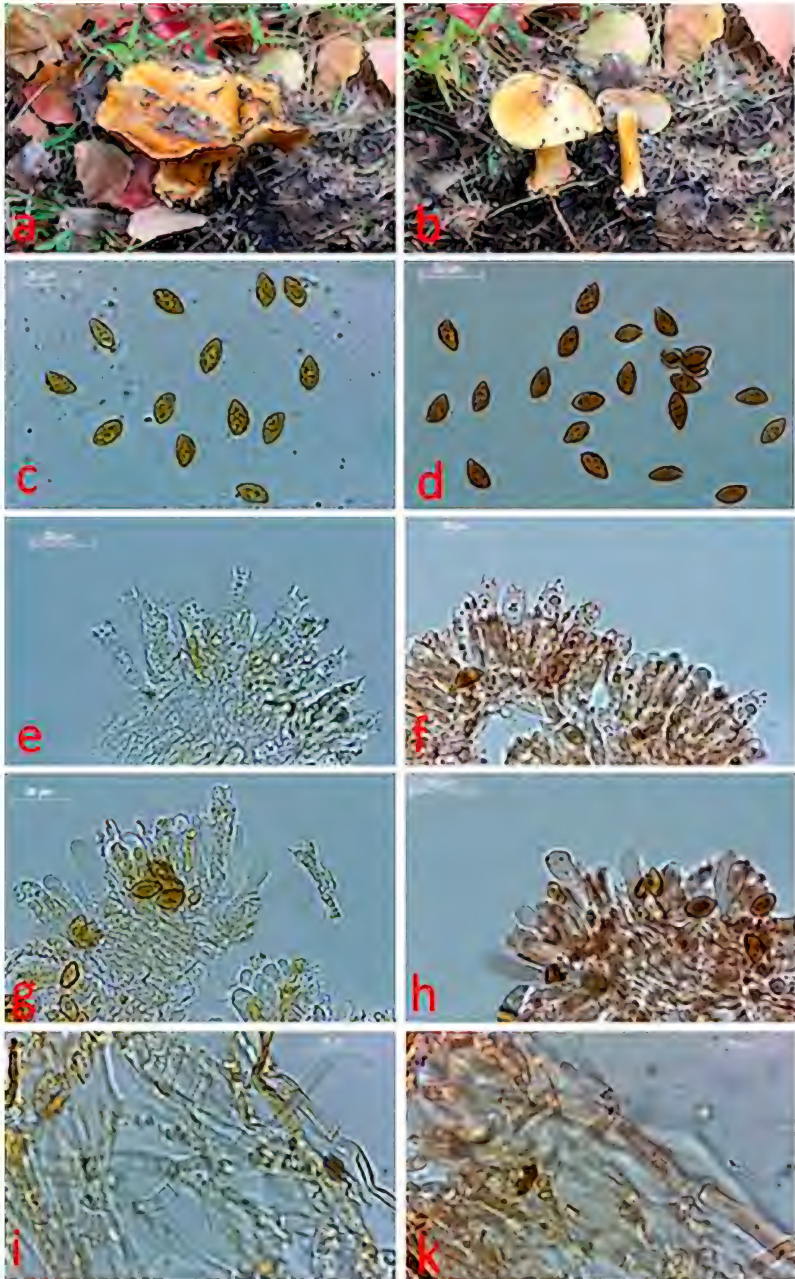


FIG. 2. *Cortinarius osmophorus* (VANF Acar1133): a, b. Basidiocarps; c, d. Basidiospores; e, f. Basidia; g, h. Marginal cells; i, k. Pileipellis. (d, f, h, k in Congo Red).

Cortinarius barbatus is morphologically similar to *C. alboamarens* Kytöv. & al. and *C. emollitoides* Bidaud & al., but the three taxa are molecularly distinct.

Cortinarius osmophorus P.D. Orton, Trans. Brit. Mycol. Soc. 43(2): 210 (1960) FIG. 2

PILEUS 50–90 mm, hemispherical to convex when young, then expanded, curved when mature, initially light yellow, whitish to cream, pale ochraceous yellow when young, ochraceous to brownish when mature, surface viscous, without veil remnants. ODOUR strong, sweetish (like orange blossoms). LAMELLAE greyish white, then brown colored. STIPE 40–70 × 7–17 mm, whitish, yellowish brown, longitudinally brown fibrillose due to cortina, the base abruptly marginate and covered with a whitish veil at the margin.

BASIDIOSPORES 9–11(–13) × (4.6–)5–6(–7) µm, amygdaliform to citriform or ellipsoid, coarsely verrucose. BASIDIA 26–40 × 6.5–9.3 µm, hyaline, cylindrical to clavate. MARGINAL CELLS 18–30 × 5–10 µm, mainly clavate, sometimes cylindrical or lageniform. PILEIPELLIS hyphae ≤8 µm diam, clamp connections present.

SPECIMEN EXAMINED: TURKEY, BINGÖL, Genç, Tarlabası village, 38.6981°N 40.490°E, 1165 m, under *Populus* and *Quercus* sp., 03.12.2018, I. Acar (VANF Acar1113; GenBank MN197666).

COMMENTS—Phillips (2006) previously reported *Cortinarius osmophorus* from beech woods on chalk, while the collection from Bingöl associated with *Populus* and *Quercus* spp.

Cortinarius osmophorus, which is similar to *C. aquilanus* T.S. Jeppesen & Frøslev, *C. cruentipellis* Kytöv. & al., *C. caesiocortinatus* Jul. Schäff., and *C. talus* Fr., characteristically has a strong orange blossom odor resembling that of *Hebeloma sacchariolens*.

Cortinarius saturninus (Fr.) Fr., Epicr. Syst. Mycol.: 306 (1838)

FIG. 3

PILEUS 30–100 mm, obtusely conic, hemispherical or campanulate when young, with or without low broad umbo, surface smooth, strongly hygrophanous, pale ochraceous, brown to reddish brown, chestnut-brown with a purple to violet tinge, centre sometimes red-brown, silvery shining, margin covered with white fragments and fibrils. LAMELLAE rather broadly adnate, cinnamon to purple-brown, then ocher brown, often with a violet tinge, edge paler. STIPE 30–80 × 7–18 mm, cylindrical, often slender, swollen towards base to subbulbous, silvery whitish to greyish violet, apex violet, covered with longitudinal white fibrils.

BASIDIOSPORES 7.5–11.7 × 4–6 µm, oblong, elliptic, amygdaliform, moderately to strongly verrucose. BASIDIA 25–37 × 5–10 µm, hyaline, cylindrical

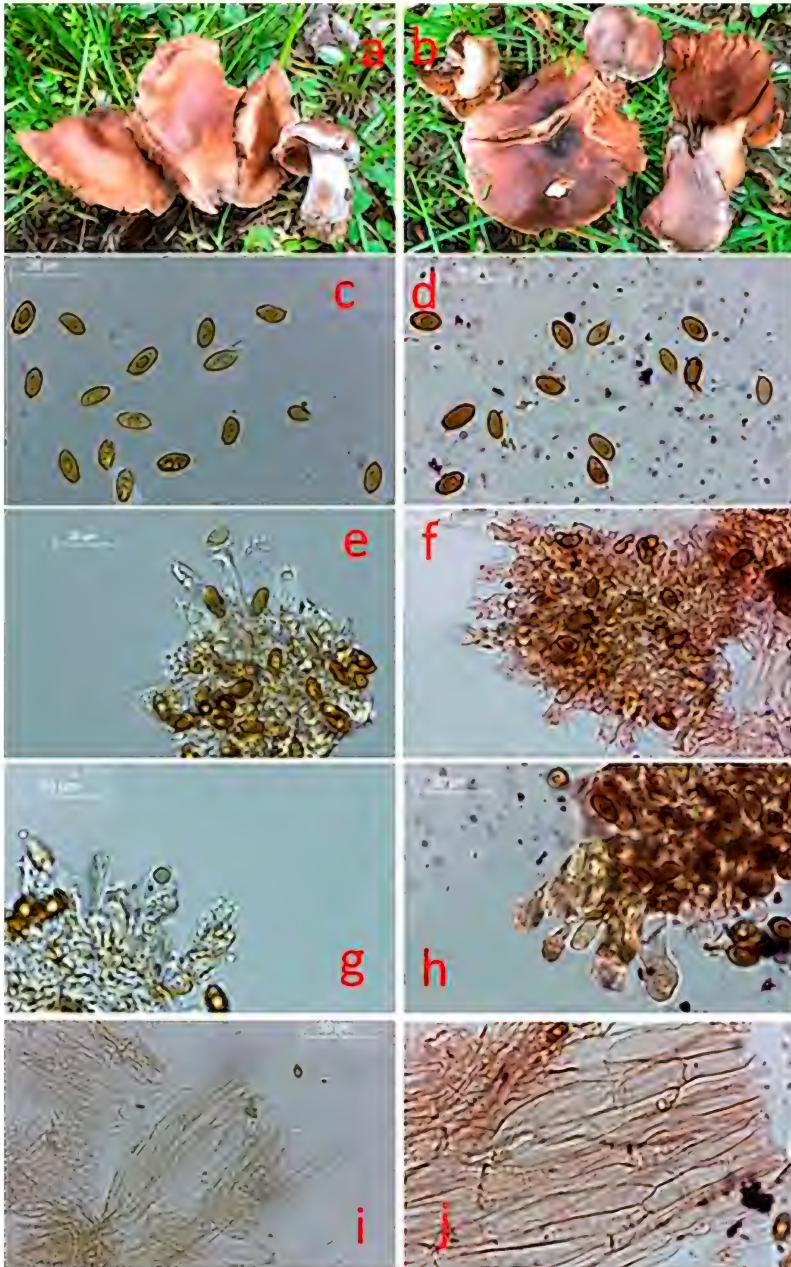


FIG. 3. *Cortinarius saturninus* (VANF Acar1055): a, b. Basidiocarps; c, d. Basidiospores; e, f. Basidia; g, h. Marginal cells; i-j. Pileipellis (d, f, h, j in Congo Red).

to clavate, 4 spored. MARGINAL CELLS $17\text{--}25 \times 4\text{--}7.5\ \mu\text{m}$, cylindrical to clavate. PILEIPELLIS hyphae $\leq 18\ \mu\text{m}$ diam, clamp connections absent.

SPECIMEN EXAMINED: TURKEY, BITLIS, Kuzgunkuran gateway, 38.3644°N 42.7561°E , 1938 m, roadside, under *Salix* sp. trees, 15.05.2018, I. Acar (VNF Acar1055; GenBank MN197667).

COMMENTS—*Cortinarius saturninus* is characterized by persistent veil remnants on the stipe and strongly verrucose spores. Lange (1938) who reported *C. saturninus* in Flora Agaricina, describes material that differs slightly [mostly ellipsoid spores] from our material due to the different ecological conditions. Our material is highly compatible with the descriptions by Phillips (2006) and Soop (2018).

Cortinarius saturninus, which is highly variable in the field, may easily be confused with *C. confirmatus* Rob. Henry, *C. cyprinus* Bidaud & al., and *C. imbutus* Fr., which can occur in similar habitats.

Discussion

Cortinarius barbatus belongs to *C. sect. Vibratiles* (in *C. subg. Myxacium*) and characterized by white pileus and stipe, bitter flesh, and amygdaloid spores (Soop 2018; Soop & al. 2019). *Cortinarius sect. Vibratiles* is characterized by medium-small size basidiomes, a viscous pileus and stipe, and bitter context. Phylogenetically *C. barbatus* appears closely related to *C. alboamarens* and *C. emollitoides*. Determining *C. barbatus* and *C. alboamarens* to species can be difficult because of the morphological similarities. ITS sequence differences separated *C. barbatus* (our sample) from *C. alboamarens* with fewer than 10 substitutions and indel positions. *Cortinarius alboamarens* is characterized by very small almost subglobose spores and is the only known white species of the section that occurs in coniferous forests (Ariyawansa & al. 2015). *Cortinarius emollitoides* is distinguished from *C. barbatus* by its viscid yellow to yellow-brown pileus and less bitter taste.

Phylogenies by Garnica & al. (2005) and Frøslev & al. (2007) place *C. osmophorus* in *C. sect. Calochroi* (of *C. subg. Phlegmacium*). Species in this section are characterized by basidiomes with an abruptly marginate stipe base, well-developed gelatinous pileus, and KOH-reactive pigments (Garnica & al. 2009). *Cortinarius osmophorus* is characterized by the sticky, pale yellow to brownish pileus, abruptly marginate stipe, ornamented spores, and strong odour. The species grows mainly in *Fagus* forests in the Southern hemisphere (Phillips 2006, Frøslev & al. 2006, Soop 2018). Macroscopically, *C. osmophorus* resembles *C. aquilanus*. However, *C. aquilanus*, which grows

under *Fagus sylvatica*, is distinguished from *C. osmophorus* by its fairly sparse veil remnants and yellowish spots on the stipe (Frøslev & Jeppesen 2008). Additionally, *C. caesiocortinatus* and *C. cruentipellis* are separated from *C. osmophorus* by their purple-colored lamellae (Soop 2018).

Cortinarius saturninus, which belongs to *C. sect. Saturnini* (Liimatainen & al. 2017), differs from related species by its persistent veil remnants on the stipe and strongly verrucose spores. The species may be confused with *C. imbutus*, *C. cyprinus*, and *C. confirmatus*, also representatives of *Cortinarius* subg. *Telamonia*, in the field because they can occur in similar habitats. Lilac-greyish lamellae and abundant veil remnants on the stipe help identify *C. imbutus*. Liimatainen & al. (2017), characterize *C. confirmatus* by one of the following character combinations: (1) absence of veil remnants on the stipe and not fruiting in dense clusters, (2) abundant veil remnants on the stipe and densely fruiting under *Populus alba*, or (3) a reddish tinted pileus and densely fruiting under *Betula pendula*. Phylogenetically, *C. saturninus* (our sample) and its sister species *C. cyprinus* differ by 3 substitutions and 2 indels.

Both morphological and molecular analyses support the identification of the newly recorded *Cortinarius* species in the current study. The addition of these three additional species increases the total of reported *Cortinarius* species in Turkey to 119.

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Literature cited

- Acar İ, Kalmer A. 2018. Two new records for Turkish macromycota from Diyarbakır (Hani) Province. *Yüzcüncü Yıl University Journal of the Institute of Natural & Applied Sciences* 23(3): 212–215.
- Akata I, Kabaktepe Ş, Akgül H. 2015. *Cortinarius caperatus* (Pers.) Fr., a new record for Turkish mycobiota. *Kastamonu University Journal of Forestry Faculty* 15(1): 86–89. <https://doi.org/10.17475/kuofd.94670>
- Altschul SE, Gish W, Miller W, Myers EW, Lipman DJ. 1997. Basic local alignment search tool. *Journal of Molecular Biology* 215: 403–410. [https://doi.org/10.1016/S0022-2836\(05\)80360-2](https://doi.org/10.1016/S0022-2836(05)80360-2)
- Ammirati JF, Traquair JA, Horgen PA. 1985. Poisonous mushrooms of the northern United States and Canada. University of Minnesota Press, USA.

- Ariyawansa HA, Hyde KD, Jayasiri SC & al. 2015. Fungal diversity notes 111–252—taxonomic and phylogenetic contributions to fungal taxa. *Fungal Diversity* 75: 27–274. <https://doi.org/10.1007/s13225-015-0346-5>
- Arnolds E, Kuyper TW. 1995. Some rare and interesting *Cortinarius* species associated with *Salix repens*. *Beihefte zur Sydowia* 10: 5–27.
- Brandrud TE, Lindström H, Marklund H, Melot J, Muskos S. 1990–2018. *Cortinarius*. *Flora Photographica*, vols 1–5 (English version). Härnösand.
- Brandrud TE, Dima B, Schmidt-Stohn G. 2012. *Cortinarius* species in acidophilous-eutrophic (but not calciphilous) oak forests of S Norway and Hungary. *Journal des J.E.C.* 14: 7–26.
- Brandrud TE, Dima B, Schmidt-Stohn G, Bellù F, Frøslev TG, Oertel B, Saar G, Soop K. 2014. *Cortinarius* subgenus *Phlegmacium* section *Multiformes* in Europe. *Journal des J.E.C.* 16: 162–199.
- Doyle JJ, Doyle JL. 1987. A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemical Bulletin* 19: 11–15.
- Frøslev TG, Jeppesen TS. 2008. Three new species of *Cortinarius* subgenus *Phlegmacium*. *Mycotaxon* 106: 469–477.
- Frøslev TG, Matheny PB, Hobbitt DS. 2005. Lower level relationships in the mushroom genus *Cortinarius* (*Basidiomycota*, *Agaricales*): a comparison of RPB1, RPB2, and ITS phylogenies. *Molecular Phylogenetics and Evolution* 37(2): 602–618. <https://doi.org/10.1016/j.ympev.2005.06.016>
- Frøslev TG, Jeppesen TS, Læssøe T. 2006. Seven new calochroid and fulvoid species of *Cortinarius*. *Mycological Research* 110: 1046–1058, <https://doi.org/10.1016/j.mycres.2006.05.012>
- Frøslev TG, Jeppesen TS, Læssøe T, Kjølner R. 2007. Molecular phylogenetics and delimitation of species in *Cortinarius* section *Calochroi* (*Basidiomycota*, *Agaricales*) in Europe. *Molecular Phylogenetics and Evolution* 44: 217–227. <https://doi.org/10.1016/j.ympev.2006.11.013>
- Garnica S, Weiß M, Oertel B, Oberwinkler F. 2003. Phylogenetic relationships of european *Phlegmacium* species (*Cortinarius*, *Agaricales*). *Mycologia* 95(6): 1155–1170. <https://doi.org/10.1080/15572536.2004.11833025>
- Garnica S, Weiß M, Oertel B, Oberwinkler F. 2005. A framework for a phylogenetic classification in the genus *Cortinarius* (*Basidiomycota*, *Agaricales*) derived from morphological and molecular data. *Canadian Journal of Botany* 83: 1457–1477. <https://doi.org/10.1139/b05-107>
- Garnica S, Weiß M, Oertel B, Ammirati JF, Oberwinkler F. 2009. Phylogenetic relationships in *Cortinarius*, section *Calochroi*, inferred from nuclear DNA sequences. *BMC Evolutionary Biology* 9(1): [17 p.]. <https://doi.org/10.1186/1471-2148-9-1>
- Güngör H, Solak MS, Allı H, Işıloğlu M, Kalmış E. 2015. New records for Turkey and contributions to the macrofungal diversity of Isparta Province. *Turkish Journal of Botany* 39: 867–877. <https://doi.org/10.3906/bot-1406-28>
- Holund K, Holst-Jensen A. 2000. *Cortinarius* phylogeny and possible taxonomic implications of ITS rDNA sequences. *Mycologia* 92(4): 694–710. <https://doi.org/10.1080/00275514.2000.12061210>
- Kalmer A, Acar İ, Dizkırıcı Tekpınar A. 2019. Phylogenetic and taxonomic studies on *Cortinarius caeruleus* (Schaeff.) Fr. a new record for Turkish mycota. *The Journal of Fungus* 10(1): 8–16.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. *Dictionary of the fungi*, 10th ed. CAB International. Wallingford, UK.

- Lange JE. 1938. Flora Agaricina Danica, vol. 3. Printed by recato A/S Copenhagen.
- Liimatainen K. 2013. Towards a better understanding of the systematics and diversity of *Cortinarius*, with an emphasis on species growing in boreal and temperate zones of Europe and North America. Academic dissertation, Faculty of Biological and Environmental Sciences of the University of Helsinki.
- Liimatainen K, Niskanen T. 2013. *Cortinarius bovarius* (Agaricales), a new species from western North America. MycoKeys 14: 7–23. <https://doi.org/10.3897/mycokeys.7.5182>
- Liimatainen K, Niskanen T, Dima B, Kytövuori I, Ammirati JF, Frøslev TG. 2014. The largest type study of Agaricales species to date: bringing identification and nomenclature of *Phlegmacium* (*Cortinarius*) into the DNA era. Persoonia 33: 98–140. <https://doi.org/10.3767/003158514X684681>.
- Liimatainen K, Carteret X, Dima B, Kytövuori I, Bidaud A, Reumaux P, Niskanen T, Ammirati JF, Bellanger JM. 2017. *Cortinarius* section *Bicolores* and section *Saturnini* (*Basidiomycota*, *Agaricales*), a morphogenetic overview of European and North American species. Persoonia 39: 175–200. <https://doi.org/10.3767/persoonia.2017.39.08>
- Niskanen T, Liimatainen K, Ammirati JF. 2013. Five new *Telamonia* species (*Cortinarius*, *Agaricales*) from western North America. Botany 91: 478–485.
- Ortega A, Suarez-Santiago VN, Reyes JD. 2008. Morphological and ITS identification of *Cortinarius* species (section *Calochroi*) collected in Mediterranean *Quercus* woodlands. Fungal Diversity 29: 73–88.
- Peintner U, Moser MM, Thomas KA, Manimohan P. 2003. First records of ectomycorrhizal *Cortinarius* species (*Agaricales*, *Basidiomycetes*) from tropical India and their phylogenetic position based on rDNA ITS sequences. Mycological Research 107(4): 485–494. <https://doi.org/10.1017/S0953756203007585>
- Phillips R. 2006. Mushrooms. London, United Kingdom. Pan Macmillan.
- Sesli E. 2018. *Cortinarius* ve *Lyophyllum* cinserline ait yeni kayıtlar. Mantar Dergisi 9: 18–23.
- Sesli E, Denchev CM. 2014. Checklists of the myxomycetes, larger ascomycetes, and larger basidiomycetes in Turkey. 6th edn. Mycotaxon Checklists Online. 136 p. <http://www.mycotaxon.com/resources/checklists/sesli-v106-checklist.pdf>
- Sesli E, Liimatainen K. 2018. *Cortinarius conicoumbonatus* (*Cortinarius* subgen. *Telamonia* sect. *Hinnulei*): a new species from spruce-beech forests of the East Black Sea Region of Turkey. Turkish Journal of Botany 42: 327–334. <https://doi.org/10.3906/bot-1710-8>
- Sesli E, Moreau PA. 2015. Taxonomic studies on some new fungal records from Trabzon, Turkey. Turkish Journal of Botany 39(5): 857–866. <https://doi.org/10.3906/bot-1409-45>
- Sesli E, Contu M, Vila J, Moreau PA, Battistin E. 2015. Taxonomic studies on some agaricoid and boletoid fungi of Turkey. Turkish Journal of Botany 39: 134–146. <https://doi.org/10.3906/bot-1403-63>
- Sesli E, Türkel İ, Akata I, Niskanen T. 2016. New records of *Basidiomycota* from Trabzon, Tokat, and İstanbul provinces in Turkey. Turkish Journal of Botany 40: 531–545. <https://doi.org/10.3906/bot-1601-12>
- Soop K. 2018. *Cortinarius* in Sweden, 16th revised ed. Editions scientrix. Sweden.
- Soop K, Dima B, Cooper JA, Park D, Oertel B. 2019. A phylogenetic approach to a global supraspecific taxonomy of *Cortinarius* (*Agaricales*) with an emphasis on the southern mycota. Persoonia 42: 261–290.

- Stefani FO, Jones RH, May TW. 2014. Concordance of seven gene genealogies compared to phenotypic data reveals multiple cryptic species in Australian dermocyboid *Cortinarius* (Agaricales). *Molecular Phylogenetics and Evolution* 71: 249–260. <https://doi.org/10.1016/j.ympev.2013.10.019>
- Stensrud O, Orr RJS, Roberg KR, Schumacher T, Hoiland K. 2014. Phylogenetic relationships in *Cortinarius* with focus on North European species. *Karstenia* 54: 57–71. <https://doi.org/10.29203/ka.2014.464>
- Uzun Y, Acar İ, Akata I, Akçay ME. 2013. Three new records for Turkish *Cortinarius* from Bingöl province. *Biological Diversity and Conservation* 6 (3): 160–163.
- Wen J, Zimmer EA. 1996. Phylogeny and biogeography of *Panax* L. (the ginseng genus, *Araliaceae*): inferences from ITS sequences of nuclear ribosomal DNA. *Molecular Phylogenetics and Evolution* 6: 167–177. <https://doi.org/10.1006/mpev.1996.0069>
- Zerova MY, Sosin PE, Rozhenko GL. 1979. [*Basidiomycetes: Boletales, Strobilomycetales, Tricholomatales, Entolomatales, Russulales, Agaricales, Gasteromycetes*]. *Visnachnik Hribyv Ukraini* [Handbook of the Fungi of Ukraine] 5(2). 566 p. Naukova Dumka: Kiev.